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Identification of Problem Areas in Water Pollution Control Plants

Research Report No. 15

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IDENTIFICATION OF PROBLEM AREAS IN WATER POLLUTION CONTROL PLANTS

by

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RESEARCH PROGRAM FOR THE ABATEMENT
OF MUNICIPAL POLLUTION WITHIN THE
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ABSTRACT

This project was carried out to study problem areas commonly encountered in wastewater treatment facilities, as determined from responses of Water Pollution Control Plant operators to a questionnaire circulated to 162 WPCP's in Ontario.

The data gathered were used to study areas of design, operational problems, operator education and training needs, and to examine general correlations which could be useful in improving plant performance and mechanical operation.

The overall responses indicated that the major problem area in WPCP operation is that of hydraulic overloading. The incidence of hydraulic overloading is independent of plant size; in addition, a significant percentage of plants constructed in the last five years are overloaded. Hydraulic overloading was found to affect pumping capacity, grit removal and secondary clarifier operation.

The responses also showed that equipment performance, reliability, and maintenance were satisfactory; however, a general need for additional flow measuring devices was indicated.

The questionnaire section on staff training showed a considerable need for further operator education in plant testing procedures, interpretation and application of laboratory results, wastewater treatment processes, safety, and equipment repair. There appeared to be considerable misunderstanding as to the degree of process testing required and the minimum hours of supervision necessary for proper process control.

RÉSUMÉ

On a réalisé le présent projet afin d'étudier les problèmes qu'on rencontre souvent dans les installations d'épuration des eaux usées, et qui avaient été identifiés à partir des réponses que des opérateurs de station d'épuration d'eau avaient fournies dans un questionnaire distribué à 162 de ces stations, en Ontario.

On a utilisé les données recueillies pour étudier la conception des stations, les problèmes d'exploitation, de même que les besoins de formation et d'éducation des opérateurs, et pour examiner les corrélations générales qui pourraient servir à l'amélioration du rendement de ces stations et de leur fonctionnement mécanique.

Dans l'ensemble, les réponses ont montré que le principal problème de fonctionnement des stations d'épuration d'eau est celui de la surcharge hydraulique, qui est d'ailleurs indépendante de la grosseur de la station; de plus, un pourcentage important des stations construites au cours des cinq dernières années sont surchargées. Il a été observé que la surcharge hydraulique influence le débit du pompage, l'élimination du sable et le fonctionnement du clarificateur secondaire.

Les réponses ont aussi montré que le rendement du matériel, sa fiabilité et son entretient étaient satisfaisants; toutefois, elles ont reflété un besoin général de dispositifs supplémentaires pour la mesure du débit.

La partie du questionnaire portant sur la formation du personnel a trahi un besoin impérieux d'éducation supplémentaire pour les opérateurs en ce qui a trait aux modes d'essais à utiliser dans les stations, à l'interprétation et à l'utilisation des résultats de laboratoire, aux méthodes d'épuration des eaux usées, à la sécurité et à la réparation du matériel. Les réponses ont permis de constater une absence d'idées nettes pour ce qui est du degré d'épreuve auquel soumettre les méthodes ainsi que du minimum d'heures de surveillance requis pour en avoir un bon contrôle.

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CONCLUSIONS AND RECOMMENDATIONS

A review of the overall questionnaire responses indicated that the major problem area in WPCP operation and performance was that of hydraulic overloading. Throughout the entire questionnaire, this one problem area consistently reappeared in various forms, e.g. percentage of plants hydraulically overloaded, number of new plants hydraulically overloaded, inadequate pumping capacity due to storm flows, and clarifier operation problems due to hydraulic overloading. The preliminary results obtained to date indicate that it would be advantageous to collect additional hydraulic data with respect to refining present design criteria and perhaps examining the applicability of equalization facilities both to new and existing installations.

A need for revised design considerations for grit removal facilities, heat exchanger capacities, and flow distribution between process units in large treatment plants, was also indicated by questionnaire responses.

Equipment performance, maintenance, and reliability were not indicated as significant problems; however, additional flow measuring devices were generally requested.

The responses in the areas of plant supervision and staffing indicated that some minimum standard for plant staffing and hours of supervision should be developed to ensure adequate operation.

In addition to the definite need for operator training as indicated by the questionnaire, there also appeared to be a considerable misunderstanding as to the degree of process testing required for optimum performance of wastewater treatment systems.

The following recommendations are made, based on the above conclusions:

1. Because of the high incidence of hydraulic overloading, a re-evaluation of the methods used in projecting dry- and wet-weather flows should be considered.

2. Some minimum requirements for plant staffing and hours of supervision should be introduced to ensure continuous adequate operation.

3. The continuous expansion and development of operator training programmes is recommended.

1. INTRODUCTION

This project was undertaken by the Research Branch of the Ministry of the Environment to study problem areas commonly encountered in wastewater treatment facilities. Funding was provided under the Canada-Ontario Agreement on Great Lakes Water Quality.

Data were collected from superintendents and chief operators of Water Pollution Control Plants (WPCP's) in Ontario through a questionnaire mailed to 162 plants. The questionnaire dealt with the different areas of operation and processes used in mechanical WPCP's. Of the 162 plants surveyed, 151 or 93 percent replied.

The data gathered were used to study:

a) design modifications required to improve treatment facility performance,
b) operational problems routinely occurring at existing WPCP's,
c) requirements for operator education and training,
d) general correlations which may be of interest, e.g. plant staffing vs capacity, maximum hydraulic loadings as a function of daily flow,
e) areas requiring further studies into improving performance and mechanical operation.

The questionnaire, data analyses, and compiled data interpretation were reviewed by various Branches of the Ministry of the Environment.

2. THE QUESTIONNAIRE

The original questionnaire was prepared by members of the Research Branch and was circulated to the Project Operations and Sanitary Engineering Branches for review. In addition, questionnaires were sent to WPCP operators familiar to members of the Research Branch for comments and to obtain sample responses. The suggestions which resulted from the reviews and comments were then used in preparing the final questionnaire.

The questionnaire (see Appendix) examined the different areas of operation and processes used in mechanical WPCP's. The areas studied were:

- Pumping Station
- Influent Works
- Primary Treatment
- Secondary Treatment
- Sludge Handling
- Other Problems
- General Considerations
  (including sections on flow measuring devices, sampling, staff training and plant staffing)

The questionnaire was not designed to identify very specific problems and thus operating process data were not obtained. Data given, such as flow information, were accepted without further verification.

The questionnaire was mailed to 162 WPCP's in the Province of Ontario (68 Ministry plants, 94 non-Ministry plants). Questionnaires sent to Ministry plants were distributed by the Project Operations Branch, while municipal plant questionnaires were mailed directly from the Research Branch.

Questionnaires were completed by plant superintendents and chief operators, rather than by operations engineers or municipal clerks. Twenty-five were collected through personal interviews with the remainder being returned by mail.

The personal interviews gave plant supervisors the opportunity to discuss operational problems in detail and to express their opinions

on the survey. The general consensus was that this type of study, where a collective feedback is obtained, is important for making recommendations in order to improve sewage treatment facilities. Specific plant problems were also discussed more fully in the interviews. The nature of the responses, however, were similar to the answers of those questionnaires returned by mail.

The data obtained in the survey were compiled manually. Answers which were incomplete or which showed ambiguity were discarded. Each question was analyzed separately and percentage calculations were based on the number of responses to each question, rather than on the total number of questionnaire replies, or the total number of plants in the survey. The data interpretation performed by the Research Group was reviewed by other Ministry branches with their suggestions leading to further interpretations.

3. INTERPRETATION OF QUESTIONNAIRE RESPONSES

3.1 General Data

Of the 162 plants surveyed, 151 or 93 percent replied. Of these, there were 40 primary and 111 secondary plants. Responses were obtained from sixty-three (93%) Ministry plants and eighty-eight (93%) non-Ministry plants.

The distribution of Ministry and non-Ministry primary and secondary plants, based on plant size, is shown in Figure 1. Approximately 50 percent of the plants have a design capacity equal to or less than 1 mgd (4536 cu m/d), while 7 percent have capacities greater than 10 mgd (45360 cu m/d).

Figure 2 gives a correlation between plant supervision (hours/day) and plant size. All plants staffed less than eight hours per day had capacities equal to or less than 1 mgd (4536 cu m/d). Since 30 percent of these plants had capacities greater than 0.5 mgd (2268 cu m/d), some effort should be made to determine minimum staffing requirements for these plants. Sixty-four percent of the plants studied were staffed eight hours per day. Plants with greater than 10 mgd (45360 cu m/d) capacity were all staffed 24 hours per day.

Figures 3A and 3B show the hours/day plant supervisory distribution for Ministry and non-Ministry plants respectively. Thirty-one percent of the municipal plants and fourteen percent of the Ministry plants were staffed more than 8 hours/day. Although a larger percentage of Ministry plants had flows greater than 5 mgd (22680 cu m/d), (35 percent compared to 19 percent municipal (Figure 1)), a smaller percentage of Ministry plants were staffed more than 8 hours/day (14% compared to 31% municipal). Again, some overall evaluation of plant supervisory requirement is recommended.

3.2 Hydraulics

In order to analyze plant hydraulic loadings, the ratio of present average daily flow tc design flow was determined for each plant. The data were then grouped to determine the number and percentage of plants with the

FIGURE 1: MINISTRY AND NON-MINISTRY PLANT DISTRIBUTION ACCORDING TO PLANT TYPE AND SIZE

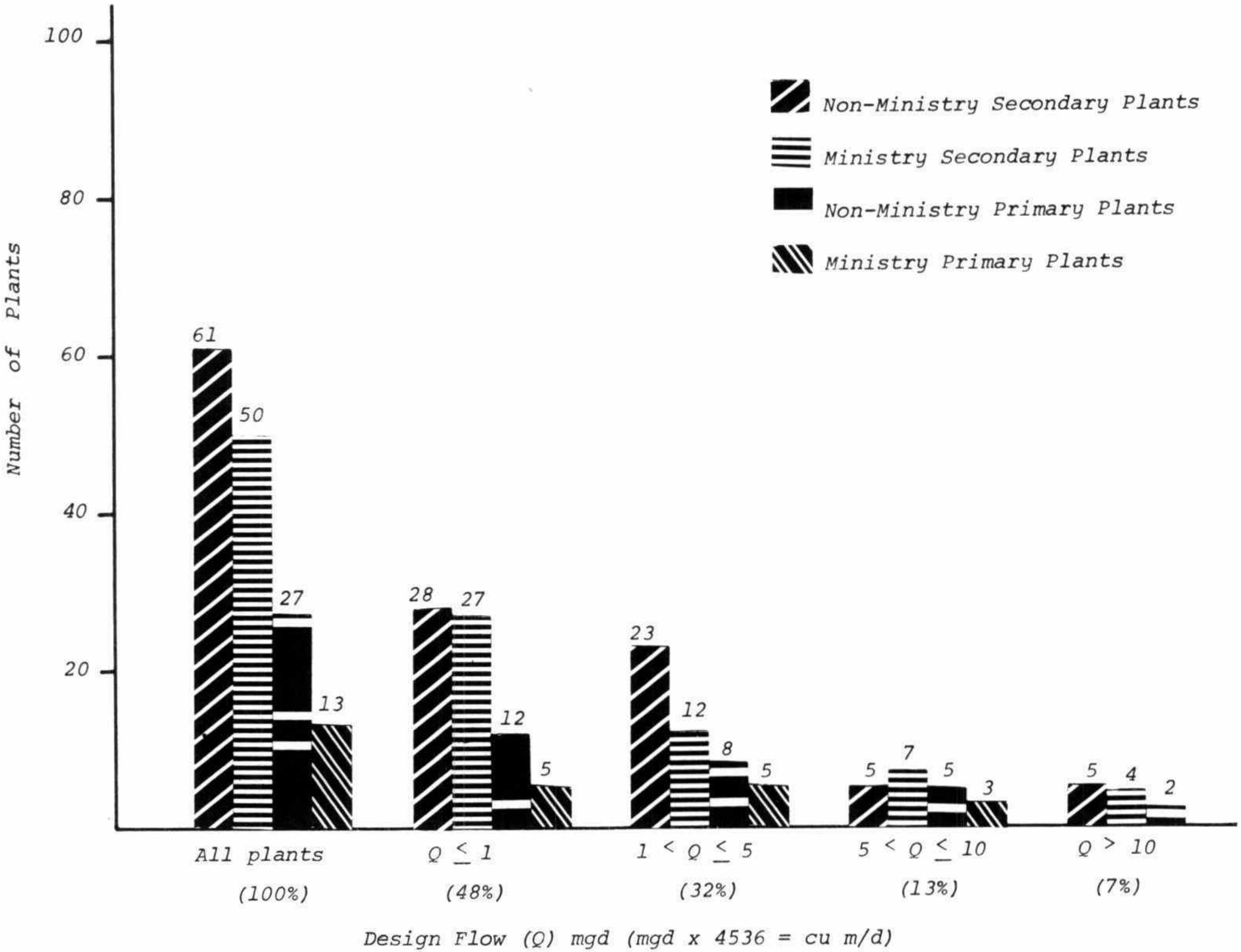


FIGURE 2: PLANT SUPERVISION RELATED TO PLANT SIZE

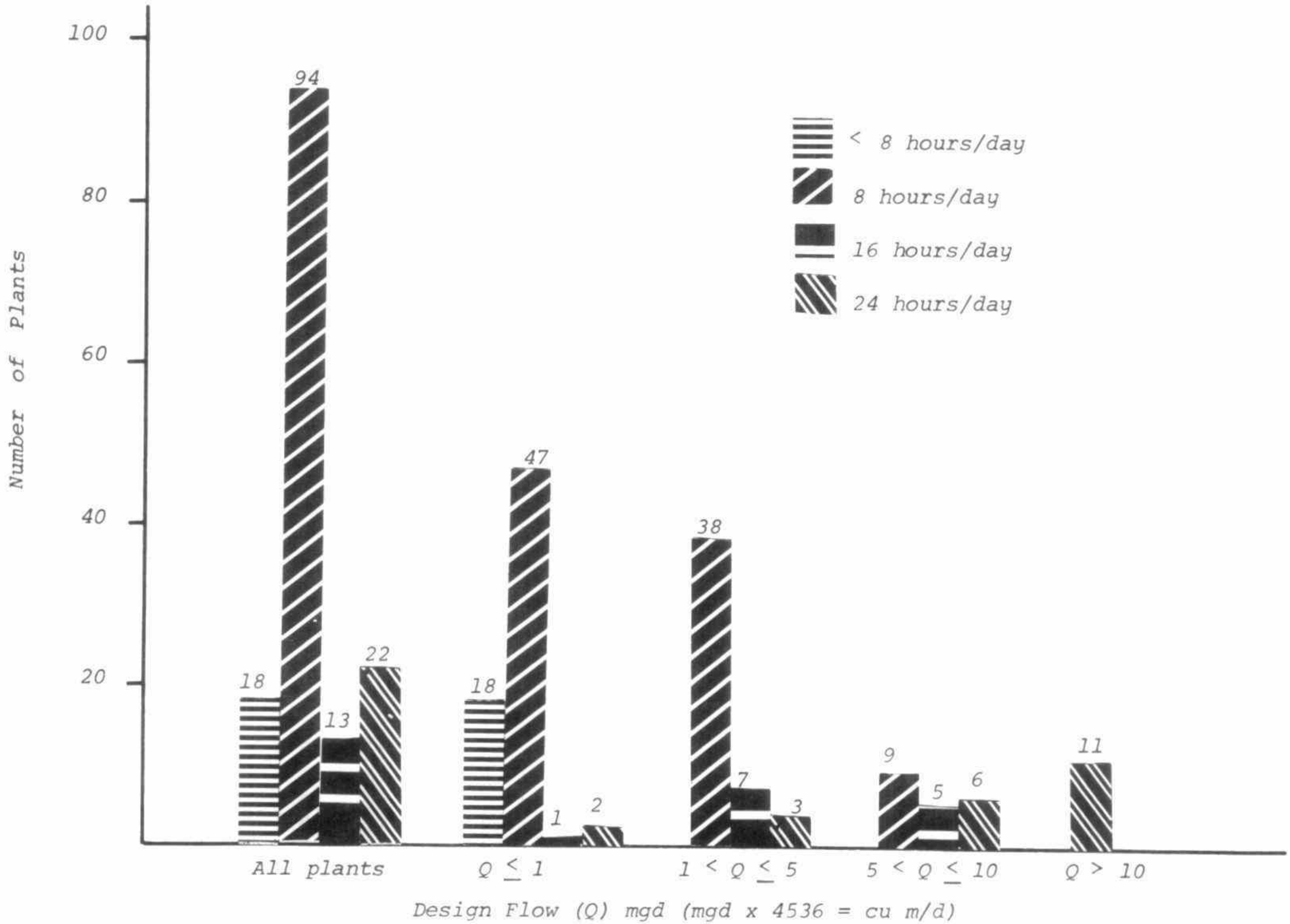
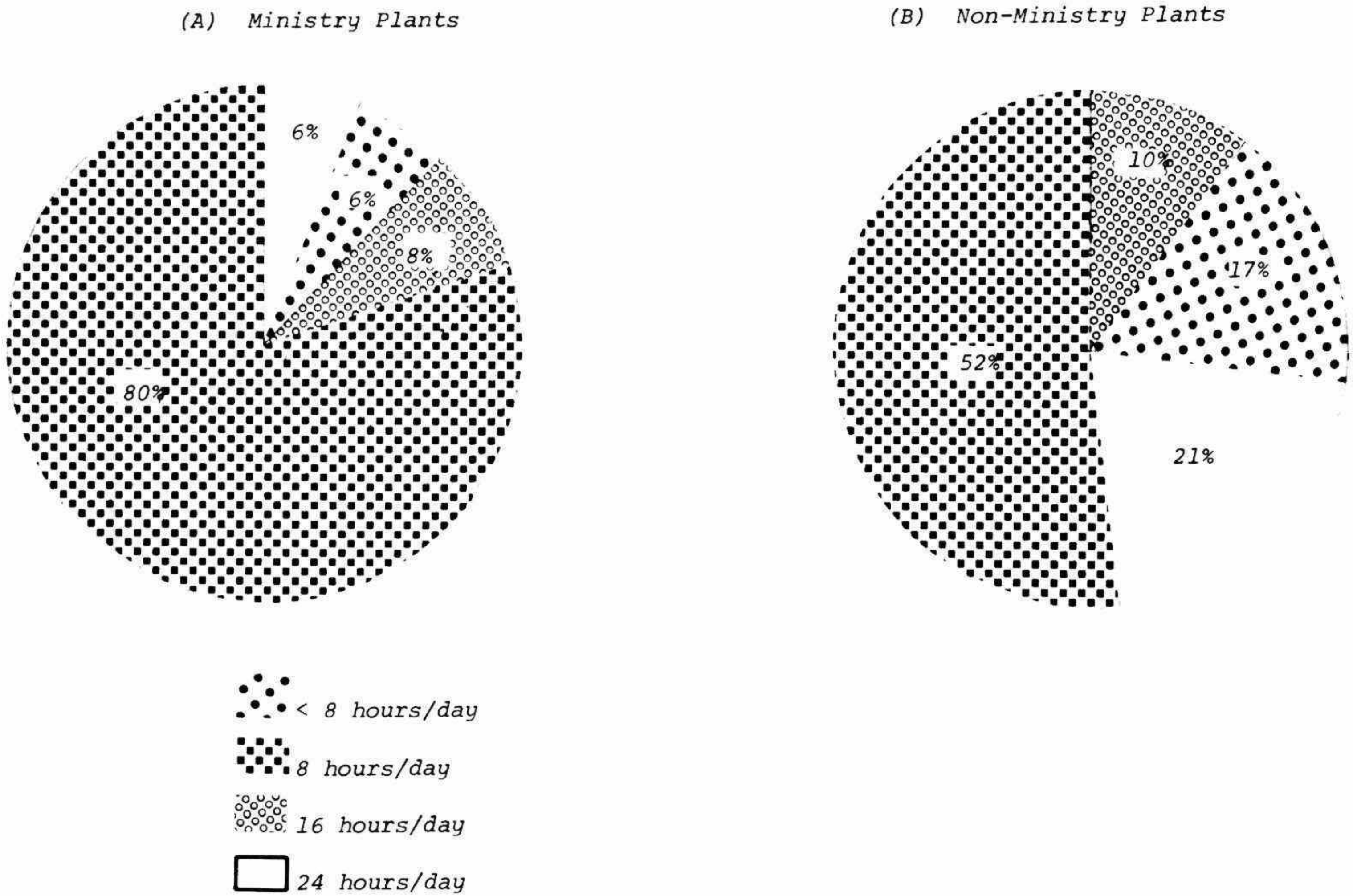


FIGURE 3: DISTRIBUTION OF PLANT SUPERVISION



above ratio greater than one, thus representing hydraulically overloaded situations. Fifty-one (34%) of the plants responding were hydraulically overloaded with twenty-two being Ministry plants (35% of all Ministry plants), and the remaining twenty-nine being municipal plants (33% of all municipal plants).

Figure 4 shows the distribution of overloaded plants with respect to plant size. The fairly uniform distribution indicates that the incidence of hydraulic overloading is independent of plant size.

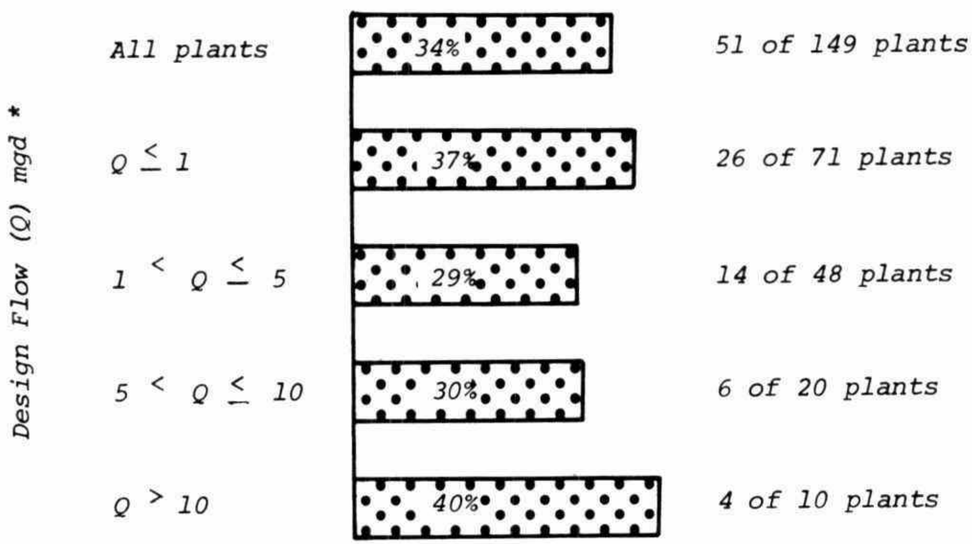
Figure 5 gives a correlation between overloaded plants and plant age. The plant age was taken as the number of years since construction or the most recent expansion of the plant. It is interesting to note that a significant percentage (33) of the plants constructed in the last five years are hydraulically overloaded; 50 percent of the plants over 20 years old are also hydraulically overloaded.

The ratio of present maximum daily flow to design flow was determined for each plant. The information obtained showed nine (10%) municipal plants and thirteen (21%) Ministry plants received maximum flows greater than twice the design capacity.

Figure 6 shows a plot of the peaking factor (present maximum daily flow/present average daily flow) versus present average daily flow. The almost horizontal "least average" line suggests that the ratio of maximum flow to average flow is independent of plant size.

Figure 7 gives the distribution of the ratio of present maximum daily flow to average daily flow for the WPCP's studied. The figure shows that ninety percent of the plants had maximum flows in the band of 1.00 to 2.49 times the average daily flows. Only 2 percent received maximum flows three times the average daily flows. Perhaps additional information should be obtained in this area to confirm or deny present design peaking factors.

FIGURE 4: HYDRAULICALLY OVERLOADED PLANTS VERSUS PLANT SIZE



* mgd x 4536 = cu m/d

FIGURE 5: HYDRAULICALLY OVERLOADED PLANTS VERSUS PLANT AGE

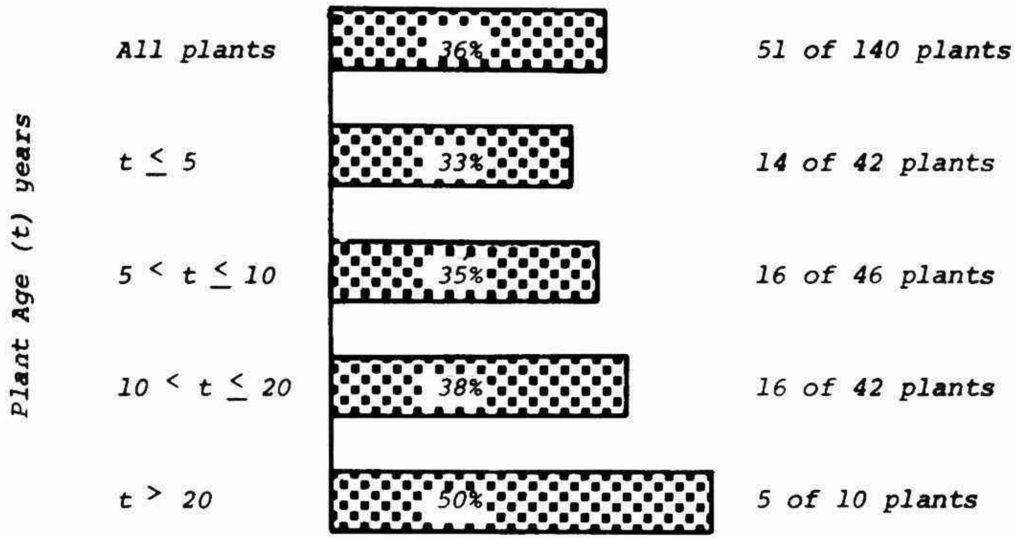


FIGURE 6: PEAKING FACTORS AS A FUNCTION OF PLANT SIZE

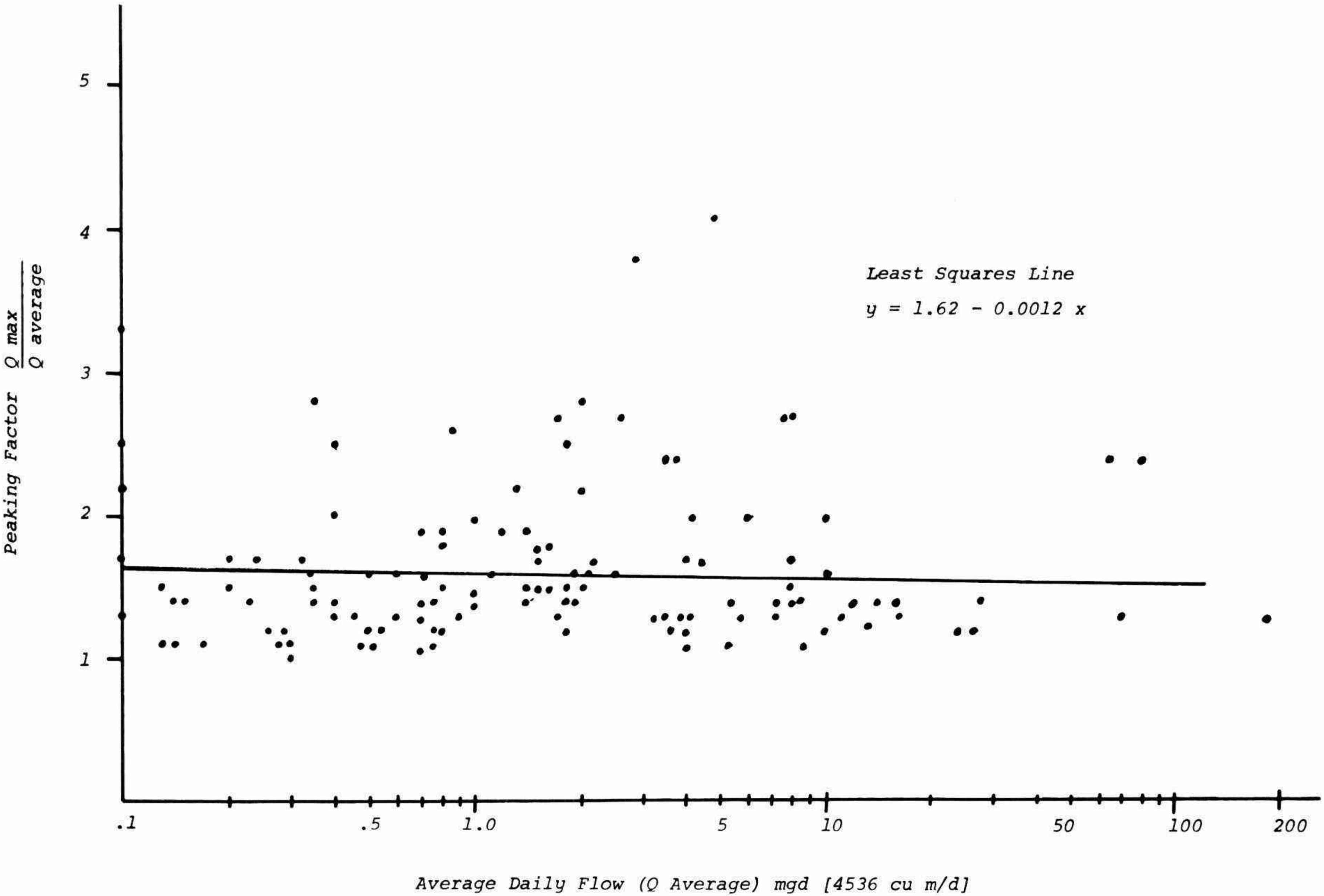
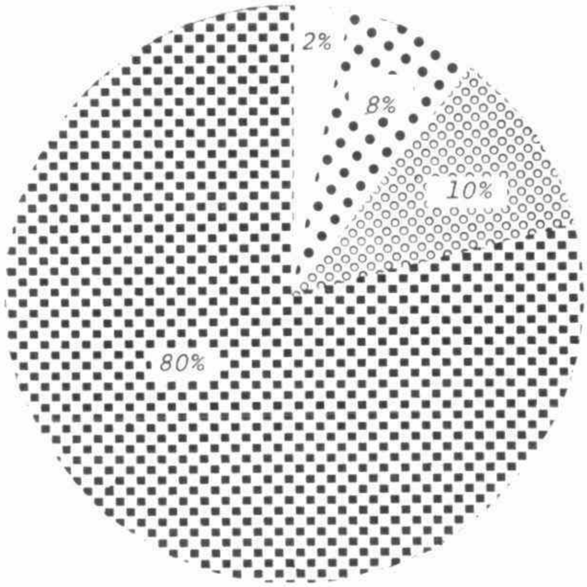


FIGURE 7: PEAKING FACTOR DISTRIBUTION



$$\text{Peaking Factor (P.F.)} = \frac{Q \text{ daily max}}{Q \text{ average}}$$

$1 < P.F. \leq 1.99$

$2.49 < P.F. \leq 2.99$

$1.99 < P.F. \leq 2.49$

$P.F. > 2.99$

3.3 Pumping Station

The data received for the pumping station section of the questionnaire are listed in Table 1.

TABLE 1 PUMPING STATION DATA

Plant Responses	Number	Percentage
(A) experiencing excessive maintenance	10	8
(B) with inadequate pumping capacity	19	16
(C) with unsatisfactory variable speed pumping	14	17
(D) that encounter problems with stand-by power facilities	7	9
(E) encountering odour problems	23	19
(F) with comments on the pumping station section of the questionnaire	45	37

The prominent problem areas indicated by the responses were:

(a) odours,

(b) unsatisfactory variable speed pumping, and

(c) inadequate pumping capacity.

Industrial discharges were found to be the major causes of pumping station odours. Discharges from chemical, poultry, and food processing industries were mentioned. The odour problem was found to occur mostly in the summer months.

The comments on the pumping station section of the questionnaire showed that problems of inadequate pumping capacity were directly related to hydraulic overloading during storm flow. Variable speed pumping problems, however, could not be associated with any particular cause or equipment type from the comments, even though a significant percentage (17) of plants had problems in this area.

The chief operators indicated in their responses that excess extraneous material present in the raw sewage caused plugging and excessive wear in pumping station equipment.

3.4 Influent Works

Table 2 shows the data received on the influent works. In this area, screening, comminution, grit removal, as well as grit handling and disposal problems were examined.

TABLE 2 INFLUENT WORKS DATA

	Plant Responses	Number	Percentage
(A)	screening problems	21	15
(B)	comminution, etc. problems	27	24
(C)	grit removal problems	46	32
(D)	grit handling and disposal problems	19	14
(E)	comments on the influent works section of the questionnaire	51	36

Thirty-two percent of the plants were found to experience problems with grit removal, the major problem being that it was necessary to remove grit manually, a time-consuming procedure. A number of plants also mentioned having grit chambers that were too short. Grit chambers, while being the least expensive method of grit removal, were undesirable to operators because of high labour requirements.

In the area of comminution, the problems of plugging and equipment wear (due to excessive grit) were of major concern.

3.5 Primary Treatment

Primary treatment data, obtained from 34 primary plants and 83 secondary treatment plants with primary facilities, are summarized in Table 3.

TABLE 3 PRIMARY TREATMENT DATA

Plant Responses	Number	Percentage
(A) excessive maintenance with their sludge collector mechanism	2	2
(B) scum collection and disposal problems	33	28
(C) problems in flow distribution between clarifiers	14	13
(D) unsatisfactory sludge withdrawal and pumping facilities	32	27
(E) comments on the primary section of the questionnaire	50	43

The data show that twenty-eight percent of the WPCP's studied experienced scum collection and disposal problems, with freezing of scum during the winter months and plugging of pipes being of major concern.

Although only fourteen plants (13%) experienced problems with flow distribution, this would appear to be a situation readily remedied by greater attention to hydraulic design considerations.

As shown in Table 3, the incidence of sludge withdrawal and pumping problems was high (27%); however, the comments received did not indicate any general repetitive problem areas. Similarly, the comments received on most of this section were scattered and could not be grouped for any useful interpretation.

3.6 Secondary Treatment

In the secondary treatment analyses, data pertaining to aeration, secondary clarifier operation, batch and continuous wasting, and chlorination were obtained from 109 secondary plants. The data received on the aeration section are summarized in Table 4.

3.6.1 Aeration Section

From the data in Table 4, it appears that maintenance and foaming problems occur in a greater percentage of mechanical aeration systems than diffused air systems. The comments showed that the removal of ice during winter months from mechanical systems was the major maintenance requirement. In the diffused air systems, plugging of the diffusers was the major problem area. Additional maintenance in mechanically aerated plants may also be the simple result of having a greater number of mechanical units, i.e. generally one motor and gearbox for each surface aerator.

TABLE 4 AERATION SECTION DATA

Plant Responses	Number	Percentage
(A) diffused air systems and experiencing:	70	64
1) maintenance problems	10	14
2) foaming problems	10	14
3) odour problems	10	14
(B) mechanical systems and experiencing:	33	30
1) maintenance problems	7	21
2) foaming problems	8	24
3) odour problems	0	0
(C) diffused and mechanical systems	6	6
(D) comments on the aeration section	32	29

Possibly the increased foaming problems experienced are a result of more violent surface action with mechanical aerators; possibly the outmoded concept that mechanical aeration systems must carry lower mixed liquor suspended solids concentrations still prevails, thus encouraging increased foaming.

The absence of odour problems with mechanical aeration systems likely indicates the reserve aeration capacity inherent in mechanical aeration systems.

3.6.2 Secondary Clarifier

The data collected on the secondary clarifier section of the questionnaire are presented in Table 5.

TABLE 5 SECONDARY CLARIFIER DATA

	Plant Responses	Number	Percentage
(A)	secondary clarifier and sludge return system problems with:	36	34
	1) design flow $\leq$ 1 mgd *	18	25 **
	2) 1 < design flow $\leq$ 5 mgd	13	27
	3) 5 < design flow $\leq$ 10 mgd	3	15
	4) design flow > 10 mgd	2	18
(B)	excessive maintenance in the sludge collection and return system	4	4
(C)	1) air lift systems	28	26
	2) mechancial pumping systems	78	72
(D)	inadequate return system pumping capacity	13	12
(E)	flow distribution problems between secondary clarifiers with:	17	18
	1) design flow $\leq$ 1 mgd	6	8
	2) 1 < design flow $\leq$ 5 mgd	6	12
	3) 5 < design flow $\leq$ 10 mgd	2	10
	4) design flow > 10 mgd	3	27
(F)	flow distribution problems in both the primary and secondary treatment sections	11	12
(G)	comments on the secondary clarifier section	19	17

* mgd X 4536 $\doteq$ cu m/d

** a percentage of the number of plants with design flow $\leq$ 1 mgd

Thirty-four percent of the secondary plants experienced secondary clarifier and sludge return system problems. These problems, as suggested by the raw data, occurred in a greater percentage (26%) of the smaller plants with design flow less than 5 mgd (22680 cu m/d), than in the larger

plants (16%) with design flow greater than 5 mgd (22680 cu m/d). The comments indicated that flooding during high flows was the major secondary clarifier problem. Plugging of pipes and inadequate pumping capacities were the problem areas associated with the sludge return systems.

Seventeen secondary plants (18%) had flow distribution problems between the secondary clarifiers. Of these plants, eleven also had flow distribution problems between the primary clarifiers. It is interesting to note that a disproportionately high percentage (27%) of plants with greater than 10 mgd (45360 cu m/d) capacity encounter this type of problem. Again, perhaps this suggests that more attention should be given to hydraulic design considerations, particularly in large treatment plants.

3.6.3 Wasting

The information obtained on activated sludge wasting is summarized in Table 6, with an analysis done on batch and continuous wasting methods.

TABLE 6 DATA ON WASTING

	Plant Responses	Number	Percentage
(A)	batch waste	62	58
(B)	waste continuously	44	42
(C)	experience problems with activated sludge wasting	29	28
(D)	batch waste and have wasting problems	22	36
(E)	waste continuously and have wasting problems	7	16
(F)	with comments on the wasting method	10	9

The results show that, of the plants which batch waste, twenty-two (36%) had wasting problems, while only seven (16%) of the plants which waste continuously had wasting problems. Similarly, in the plants having wasting problems (29), 76 percent batch waste and 24 percent waste continuously. Such data support the need for operator training, particularly with respect to process control.

3.6.4 Chlorination

The responses to the chlorination section of the questionnaire indicated that chlorination was a fairly trouble-free area of the sewage treatment process. Only six percent of the plants responding claimed to have excessive chlorinator maintenance.

3.7 Sludge Handling

Sludge handling data obtained from 31 primary plants and 71 secondary plants having anaerobic digestion are summarized in Table 7.

TABLE 7 SLUDGE HANDLING DATA

	Number	Percentage
Number and percentage of plants with anaerobic digestion	102	68
Number and percentage of these plants with:		
(A) excessive problems in the gas collection and/or gas mixing systems	12	14
(B) inadequate heat exchangers	12	13
(C) excessive boiler and heat exchanger maintenance	9	10
(D) excessive maintenance of sludge pumping facilities	10	10
(E) sludge disposal problems	27	24
(F) operators who do not know the destination of their digested sludge after it leaves the plant	8	7
(G) comments on the anaerobic section	45	44

The main problem area in this section as indicated in Table 7 was that of sludge disposal. The comments received on this section showed that access to the disposal sites during the winter months was difficult because of wet fields. Some operators were concerned about the shortage

of space for sludge disposal. From the plant interviews it was inferred that farmers' fields, located within 15 miles from the plant sites in most cases, were the most used locations for the disposal of sludge. It is interesting to note that seven percent of the chief operators do not know where their digested sludge goes after it leaves the plant.

The presence of twelve plants with inadequate heat exchanger capacity suggests that perhaps additional work should be conducted in this area to determine whether such situations arise from design or operational problems.

3.8 Other Problems

Of the 31 percent of chief operators responding to the section of the questionnaire on other problems, most emphasized hydraulic and organic overloading problems. Equipment repair, rodent control, and the incidence of industrial shock loading were also mentioned as infrequent problems.

3.9 General Considerations

General areas of plant operation and process instrumentation were considered in the final section of the questionnaire under the heading "General Considerations".

The analysis of the responses showed that 78 percent of all plant superintendents, chief operators, etc., felt that they had accurate and reliable flow measuring devices, while 16 percent responding indicated unsatisfactory instrumentation. Six percent did not know whether their instrumentation was reliable or not.

In considering the need for further instrumentation, thirty percent of the plants requested additional flow measuring devices and process instrumentation. The need for monitoring of sludge return and sludge wasting rates were the significant areas mentioned, while process instrumentation such as pH and DO meters were not greatly requested. Analysis of the data further indicated that the need for flow measuring devices and process instrumentation was independent of plant size.

Fifty-seven percent of the responses stated that the facilities and equipment for plant operation were satisfactory, while forty percent

stated that there was room for improvement in this area. Only three percent claimed to have poor facilities.

The analysis of the data on plant process testing and sampling indicated that 17 percent of plant supervisors thought that too little time was spent in this area. Eighty-one percent of the supervisors expressed the opinion that adequate time was spent on testing and sampling.

3.10 Process Testing and Sampling

Data for the time spent on plant process testing and sampling were collected as man-hours per week with values ranging from 0.25 to 440 man-hours/week. Such values are obviously a function of plant size and were thus arbitrarily grouped in the following categories:

(a) $\leq$ 10 man-hours/week

(b) 10 < man-hours/week $\leq$ 20

(c) > 20 man-hours/week

Figures 8 and 9 illustrate the time spent according to plant type and plant size respectively. In Figure 8A for primary plants with capacities of 5 mgd (22680 cu m/d) or less, sixty-two percent of the plants spent less than 10 man-hours/week on plant process testing and sampling. Using the criteria that approximately 10 man-hours/week should be spent on plant process testing and sampling in primary plants with flows of 5 mgd (22680 cu m/d) or less, it appears that not enough time is spent on process testing and sampling in a large percentage (63%) of primary plants in Ontario.

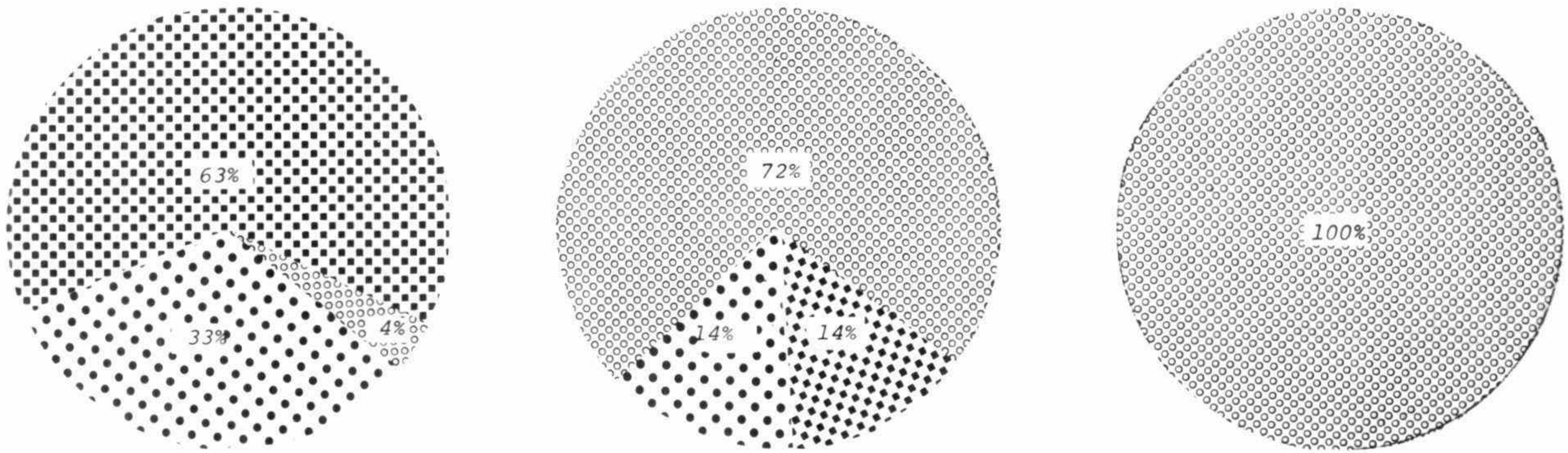
Eighty-eight percent of the secondary plants in the same capacity range, spent less than 20 man-hours/week for testing and sampling as shown in Figure 9A. Similarly using the criteria of 20 man-hours/week for secondary plants with flows of 5 mgd (22680 cu m/d) and less, a significant number (88%) do not spend adequate time sampling and testing.

The above interpretation differs greatly with that indicated in Section 3.9, where 81 percent of the plant supervisors stated that adequate time was spent on testing and sampling. Only 17 percent of the supervisors felt that too little time was spent in this area. These results indicate a great discrepancy between what plant operators consider to be adequate

FIGURE 8: PROCESS TESTING AND SAMPLING TIME DISTRIBUTION VERSUS PRIMARY PLANT SIZE

Design Flow = Q mgd (4536 cu m/d)

$Q \leq 5$ mgd (24 plants) | *$5 < Q \leq 10$ mgd (7 plants)* | *$Q > 10$ mgd (2 plants)*



x = process testing and sampling time (man-hours/week)

$x \leq 10$

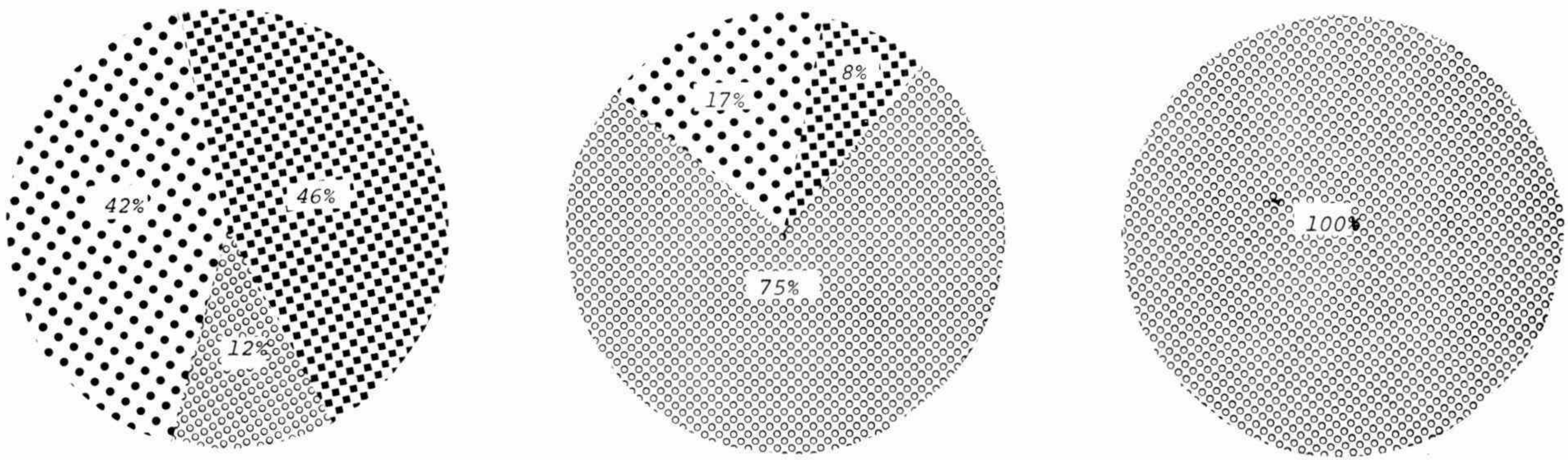
$10 < x \leq 20$

$x > 20$

FIGURE 9: PROCESS TESTING AND SAMPLING TIME AS A FUNCTION OF SECONDARY PLANT SIZE

Design Flow = Q mgd (4536 cu m/d)

(A) $Q \leq 5$ mgd (B) $5 < Q \leq 10$ mgd (C) $Q > 10$ mgd



x = process testing and sampling time (man-hours/week)

$x \leq 10$

$10 < x \leq 20$

$x > 20$

process testing and sampling time and the hypothetical values of 10 and 20 man-hours/week for primary and secondary plants, respectively, with flows less than 5 mgd (22680 cu m/d).

More than 70 percent of both primary and secondary plants with greater than 5 mgd (22680 cu m/d) capacity, spent over twenty man-hours/ week on sampling and testing (Figures 8B, C; 9B, C). Thus, there seems to be adequate time spent in this area in the larger plants. All plants with flows over 10 mgd (45360 cu m/d) spent more than twenty man-hours/week on process testing and sampling.

Figures 10A, B show the distribution of plant process testing and sampling time in primary and secondary plants, respectively, independent of plant size. Again the large percentage of plants which spend too little time for process monitoring is illustrated.

3.11 Staff Training

The section on staff training was included in the questionnaire to determine from plant operators areas requiring further staff development. The data obtained in this section are summarized in Table 8.

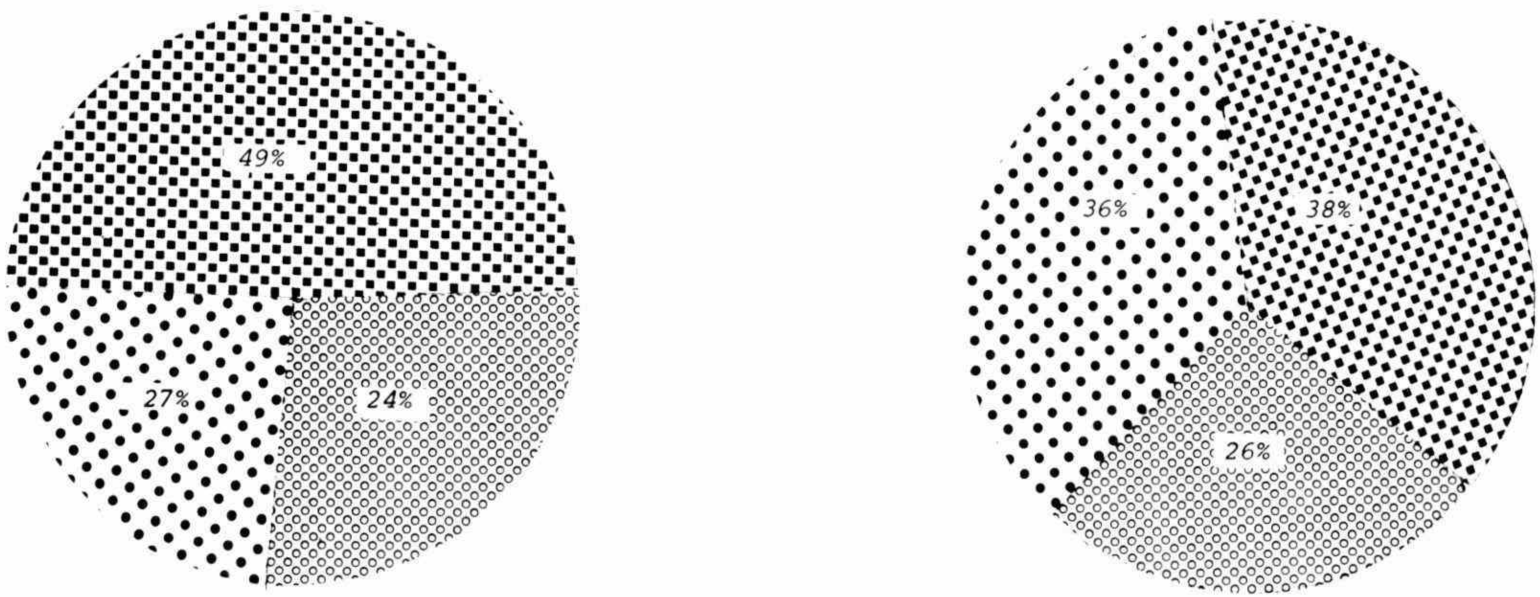
TABLE 8 STAFF TRAINING DATA

	Training Required	Number	Percentage
(A)	plant testing procedures	74	54
(B)	interpretation and application of laboratory results	86	62
(C)	wastewater treatment processes	70	52
(D)	safety	51	41
(E)	equipment repair	68	51

The responses indicated a considerable need for further operator education in the five areas considered. In the personal interviews, plant operators who had attended courses stated that they felt much more competent in plant operation and control as a result of such training. They advocated the continuous expansion and development of the training programme.

FIGURE 10: PROCESS TESTING AND SAMPLING TIME

(A) Primary Plants *(B) Secondary Plants*



x = process testing and sampling (man-hours/week)

- $x \leq 10$
- $10 < x \leq 20$
- $x > 20$

3.12 Plant Staffing

The responses obtained on plant staffing indicated that 65 percent of the chief operators thought that their plants were adequately staffed; 35 percent claimed to have plants that were understaffed. Of the plants that were adequately staffed, 84 percent claimed to spend enough time on process testing and sampling. Only 14 percent of these plants suggested that too little time was spent for this purpose. This again differs greatly from the information deduced in Section 3.10 on process testing and sampling. It is obvious that inadequate plant testing and sampling was not a result of understaffing but rather a misunderstanding of the degree of process control considered satisfactory, yet only a small percentage of these plants spend enough time monitoring the process.

Figure 11 illustrates the number of full-time staff versus plant size for primary plants. Figure 12 shows the same comparison for secondary plants. In the latter, the range of full-time staff for a particular design flow is wide, e.g. for 4 mgd (18144 cu m/d) capacity, the number of full-time staff ranges from two to nine. Similarly, two plants with the same design capacity, [10 mgd (45360 cu m/d)] were found to employ nine and twenty-six full-time staff, respectively. The range of values in Figure 11 for primary plants is much smaller and is fairly consistent for all plant sizes. Additional responsibilities (e.g. industrial wastes by-law enforcement) beyond normal WPCP operation probably contribute to some of the observed incongruities in plant staffing.

Considering the differences in complexity and labour requirements for primary and secondary plants, it is interesting to note the similarities between Figures 11 and 12.

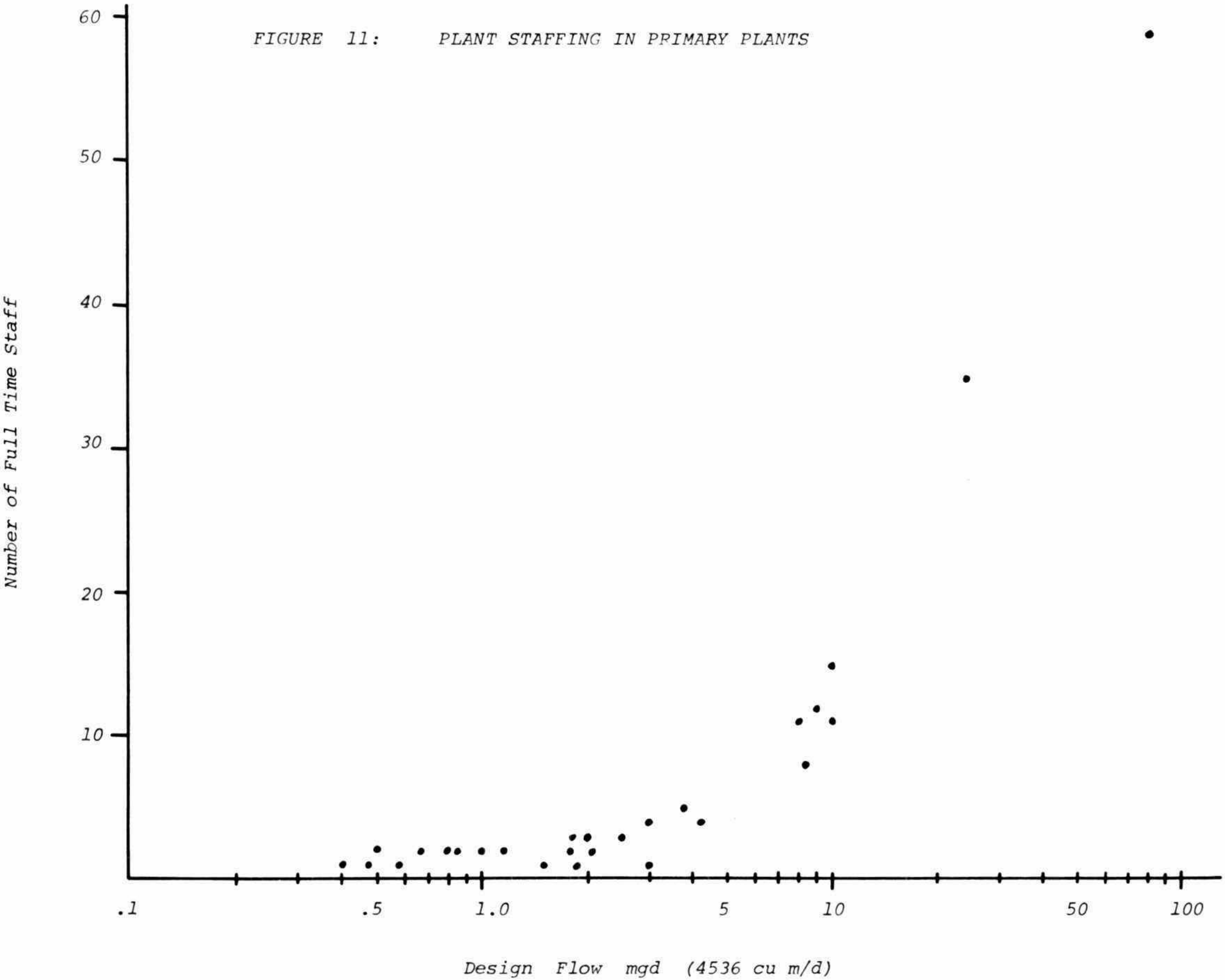
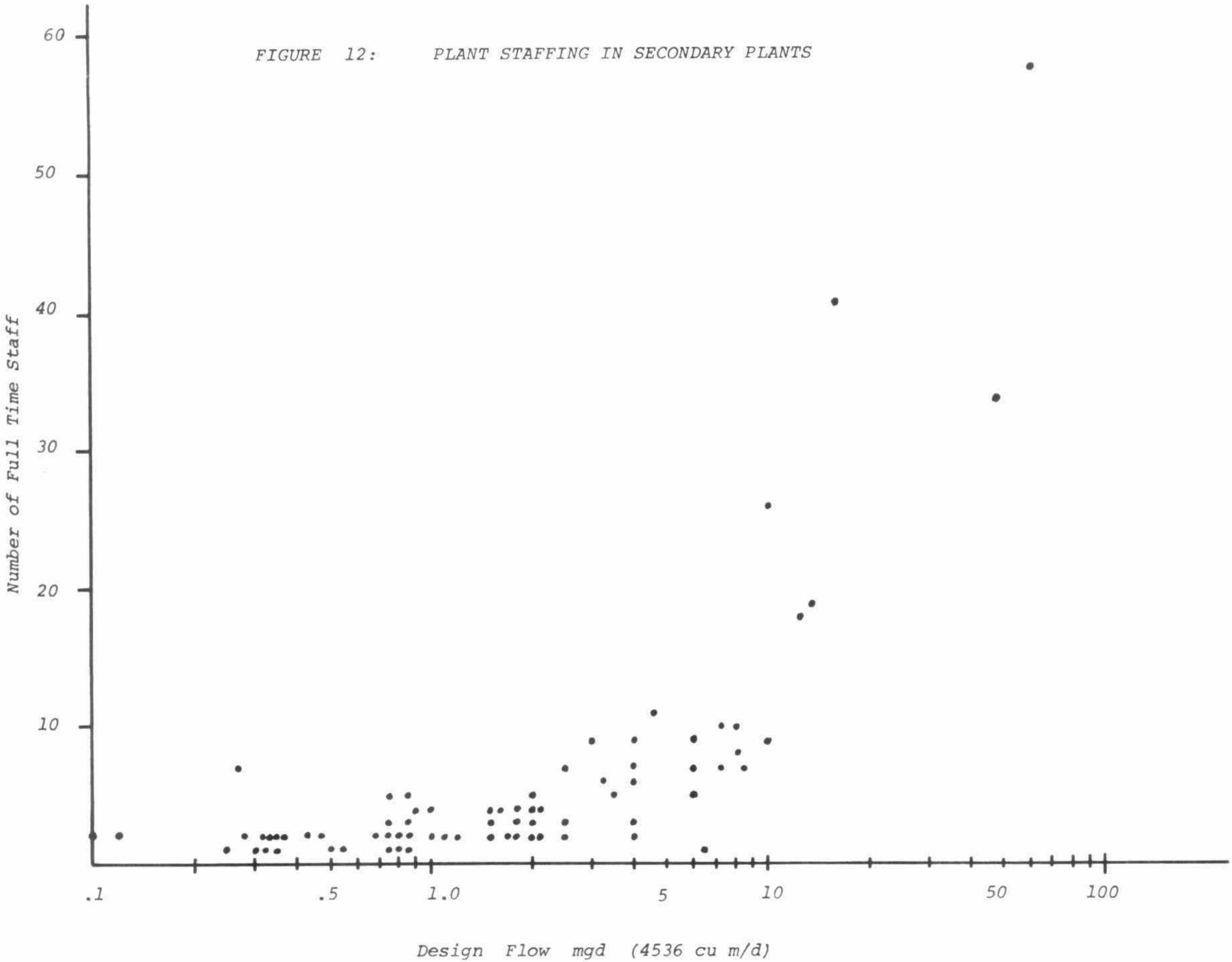


FIGURE 11: PLANT STAFFING IN PRIMARY PLANTS

FIGURE 12: PLANT STAFFING IN SECONDARY PLANTS



4. DISCUSSION AND CONCLUSIONS

A review of the overall questionnaire responses indicated that the major problem area in WPCP operation and performance was that of hydraulic overloading. Throughout the entire questionnaire, this one problem area consistently reappeared in various forms, e.g. percentage of plants hydraulically overloaded, number of new plants hydraulically overloaded, number of new plants hydraulically overloaded, inadequate pumping capacity due to storm flows, and clarifier operation problems due to hydraulic overloading. The preliminary results obtained to date indicate that it would be advantageous to collect additional hydraulic data with respect to refining present design criteria and perhaps examining the applicability of equalization facilities both to new and existing installations.

Other areas of the questionnaire that indicated a need for revised design considerations were grit removal facilities, heat exchanger capacities, and flow distribution between process units in large treatment plants.

Equipment performance, maintenance, and reliability were not indicated as significant problems; however, additional flow measuring devices were generally requested.

The responses in the areas of plant supervison and staffing indicated that some minimum standard for plant staffing and hours of supervision should be developed to ensure adequate operation.

In addition to the definite need for operator training as indicated by the questionnaire, there also appeared to be a considerable misunderstanding as to the degree of process testing required for optimum performance of wastewater treatment systems.

5. RECOMMENDATIONS

Based on the conclusions drawn from this study, the following recommendations are made:

1. Because of the high incidence of hydraulic overloading, a re-evaluation of the methods used in projecting dry- and wet-weather flows should be considered.
2. Some minimum requirements for plant staffing and hours of supervision should be introduced to ensure continuous adequate operation.
3. The continuous expansion and development of operator training programmes is recommended.

APPENDIX

QUESTIONNAIRE

Municipality:

Plant Type: Primary ( ) Secondary ( )

Design Flow: mgd

Present Average Daily Flow: mgd

Present Maximum Daily Flow: mgd

Number of hours staffed / day:

less than 8 hours ( )

8 hours ( )

16 hours ( )

24 hours ( )

Name:

Position:

Telephone Number:

IDENTIFICATION OF PROBLEM AREAS

I PUMPING STATION

IF PUMPING STATION IS PART OF YOUR RESPONSIBILITY, COMPLETE THE FOLLOWING:

(a) How much maintenance is required?

little ( ) normal ( ) excessive ( )

		YES	NO
(b)	Is pumping capacity adequate?	( )	( )
(c)	Is variable speed pumping (flow matching) satisfactory?	( )	( )
(d)	Do you encounter any problems in starting your stand-by power facilities?	( )	( )

If yes, specify:

(e)	Are odours a nuisance?	( )	( )

(f) Comments:

II INFLUENT WORKS

		YES	NO
Do you have any problems in the following areas?			
(a)	Screening	( )	( )
(b)	Comminution (shredding, barminution, etc.)	( )	( )
(c)	Grit removal	( )	( )
	If yes, specify method of removal and nature of problem:		
(d)	Grit handling and disposal	( )	( )
(e)	Comments:		

III PRIMARY TREATMENT

IF YOUR PLANT HAS PRIMARY CLARIFIERS, COMPLETE THE FOLLOWING:

(a) How much maintenance is required with your sludge collector mechanism?

little ( ) normal ( ) excessive ( )

		YES	NO
(b)	Is scum collection and disposal a problem?	( )	( )
(c)	Is flow distribution between clarifiers a problem?	( )	( )
(d)	Are facilities for sludge withdrawal and pumping satisfactory?	( )	( )

(e) Comments:

IV SECONDARY TREATMENT

1) Aeration System:

(a) Type of Aeration system:

diffused air ( ) mechanical ( )

	YES	NO
(b) Do you have maintenance problems with the aeration system?	( )	( )

If yes, specify:

(c) Is foaming a problem?	( )	( )
(d) Are aeration tank odours a problem?	( )	( )

(e) Comments:

2) Secondary Clarifier: YES NO

(a) Do you have problems with your secondary clarifier and sludge return system? ( ) ( )

If yes, specify:

(b) How much maintenance is required with your sludge collection and return system?

little ( ) normal ( ) excessive ( )

(c) What type of sludge return system is used?

air lift ( ) mechanical pumping ( )

gravity ( ) other ( )

YES NO

(d) Is your return system pumping capacity adequate? ( ) ( )

(e) Is flow distribution between clarifiers a problem? ( ) ( )

(f) Comments:

3) Wasting:

(a) Do you have problems with activated sludge wasting? ( ) ( )

If yes, specify:

(b) What method of sludge wasting is used?

batch ( ) continuous ( )

(c) Comments:

4) Chlorination:

(a) How much chlorinator equipment maintenance is required?

little ( ) normal ( ) excessive ( )

(b) What type of chlorinator equipment do you have?

Wallace and Tiernan ( ) BIF ( )

Fischer and Porter ( ) other ( )

(c) Comments:

V SLUDGE HANDLING

IF YOUR PLANT HAS ANAEROBIC DIGESTION, COMPLETE THE FOLLOWING:

(a) How much problem do you have with your gas collection and/or gas mixing systems?

little ( ) normal ( ) excessive ( )

	YES	NO
(b) Is your heat exchanger adequate to maintain proper digestion temperature?	( )	( )

(c) How much problem do you have with your boiler and heat exchanger maintenance?

little ( ) normal ( ) excessive ( )

(d) How much problem do you have with maintenance of your sludge pumping facilities?

little ( ) normal ( ) excessive ( )

	YES	NO
(e) Is sludge disposal a problem?	( )	( )
(f) Do you know where your digested sludge goes after it leaves the plant?	( )	( )

(g) Comments:

VI OTHER PROBLEMS

What other problems, process and/or mechanical, are encountered repeatedly?

VII GENERAL CONSIDERATIONS

		YES	NO
1)	(a) Do you feel that your flow measuring devices are accurate and reliable?		
	DON'T KNOW ( )	( )	( )

If no, specify:

		YES	NO
	(b) Do you need additional flow measuring devices or process instrumentation for daily process control?	( )	( )

If yes, specify:

(c) What generally is your opinion of the facilities and equipment provided to operate your plant?

poor ( ) room for improvement ( )

satisfactory ( )

If poor, specify:

2) (a) Do you feel the time spent on plant process testing and sampling is:

too little ( ) just right ( )

excessive ( )

(b) How much time is spent for the above?

( ) man-hours/week

(c) Do you or your staff require additional training in:

	YES	NO
i) plant testing procedures?	( )	( )
ii) interpretation and application of laboratory results?	( )	( )
iii) wastewater treatment processes?	( )	( )
iv) safety?	( )	( )
v) equipment repair?	( )	( )

3) (a) Do you feel your plant is:

understaffed ( ) adequately staffed ( )

overstaffed ( )

(b) How many full time staff are employed at your plant?

( )

4) Does your operating budget allow for satisfactory plant operation and maintenance?

( ) ( )

5) <u>General Comments:</u>